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Sent: Tuesday, March 10, 2015 9:37 AM
To: Bottcher, Helen; Scheffler, Ken/SEA; McKinley, Scott/CVO
Subject: Ecology's comments on the upper aquifer groundwater result report

Presented below are my comments on the upper aquifer groundwater results. Please let me know if you have any questions.

Chung

Comment 1. Section 1.1, page 2, line 4th from the bottom: "The absence of NAPL and groundwater extraction . . . that allows for higher equilibrium PAH concentrations."

I don't understand the term "higher equilibrium PAH concentrations." The "effective solubility estimates" were derived based on NAPL data some distances away from groundwater monitoring wells. The "effective solubility estimates" derived from monitoring wells should mainly be due to PAH distribution from nearby NAPL sources and not necessary to NAPL characteristics collected from the extraction wells. If it is higher than equilibrium, then the system is not in equilibrium. This is a matured site and the system should be in equilibrium. Are some groundwater results included both dissolved phase and NAPL phase thus resulting in "higher equilibrium PAH concentrations"? Please clarify.

Response. The rate of NAPL dissolution into groundwater is largely influenced by the groundwater flow velocity through/across the source zone. In general, higher groundwater flow velocities, such as those induced by an active pumping well system, promote greater rates of dissolution. In active pumping areas, the contact period between NAPL and groundwater is shorter, and therefore, dissolved phase concentrations may not reach the equilibrium level predicted by the effective solubility approximations. As shown on the figure included as an attachment to Helen's comment #15, there may be a groundwater velocity stagnation zone present around the perimeter of the former process area next to the sheet pile wall. In this area, groundwater velocities are much lower, which in turn promotes greater contact time, and higher dissolved phase concentrations.

Comment 2. Sections 3.1.1 Density, 3.1.2 Viscosity, and 3.1.3 Interfacial Tension

It would be helpful if there is a short discussion on the bases of the 2014 results. I do not understand some of the 2014 results relative to the 1999 results based on my understanding of impacts of weathering to TPHs and to TPAHs.

Response. Discussion Needed. Is more information needed on the test methods?

Comment 3. Section 3.2.5, "As shown in Figure 7, the LNAPL samples from extraction well RPW2 . . . a higher fraction of naphthalene . . . than RPW1 (Core Area) . . ."

Given this higher fraction of 2-ring compounds in North Shallow and East Shallow than the Core Area, does that confirm/suggest that North Shallow and East Shallow NAPLs are from different sources than the Core Area?

Response. No. Based on the information presented in Figure 8, it appears that most NAPL originated from a similar source. Based on experience at other wood treater sites, several different treatment formulations were likely used over the years with the addition of PCP later-on representing the most significant change. Changes in treatment formulation, and variability in NAPL weathering rates, and even sample collection and analysis methods, likely contribute to the variability shown on Figures 7 and 8.

Comment 4. Section 5.1: ". . . CW14, which is located about 30 feet northeast of PW09."

Please change to northwest of PW9.

Response. Accept.

Comment 5. Section 5.1, Naphthalene: "In the groundwater samples taken from wells MW17 and PO09, it was detected . . . or about 100 times lower than predicted by the effective solubility of 9,000 µg/L."

Monitoring well MW17 well screen interval is 5' to 15' bgs. Given the expected NAPL flow direction, NAPL in TarGOST polygons 056 and 019 may likely be the potential NAPL sources to dissolved phase found in MW17. At 5' to 15' bgs, the highest TarGOST %RE for the adjacent polygons 056, 019 are 0 and 40 respectively. For PO09, the well screen is 5' to 15' bgs. PO09 is located in TarGOST polygon 103 with a high of 90 %RE within the 5' to 15' bgs screen interval. The lower than predicted solubility found can largely be explained by the absent of NAPL at these polygons at the well screen intervals for these two monitoring wells.

For monitoring well CW14, the expected NAPL contributing TarGOST polygon is 122 and maybe to a lesser extent polygon 142. At the CW14 well screen interval, 26' to 36' bgs, the highest TarGOST %RE for polygon 122 is 470. For polygon 142, the highest TarGOST %RE is 70. Due to pumping of PW9, TarGOST boring 142 is downgradient of monitoring well CW14. The high value of 3,800 µg/L of naphthalene found in CW14 can be explained by the high %RE found in the upgradient TarGOST boring 122.

In my view, the concentrations of dissolved components can better be explained by nearby TarGOST results than by effective solubility estimates derived from DNAPL results from extraction wells.

Response. Discussion Needed. The lower dissolved phase concentrations present at MW-17 and PO09 may be better explained by the proximity of these two wells to RPW1 (see Figure attached to address Helen's comment #15).

Comment 6. Section 5.1, Phenanthrene: ". . . while in the CW14 groundwater sample, it was present at 200 µg/L or about 10 times higher than its effective solubility."

As suggested above, the source/characteristics of the CW14 dissolved phase contaminants may better be attributed to NAPL found in TarGOST boring 122. Otherwise, what is basis for the higher than its effective solubility assuming the system is at equilibrium and no contribution from NAPL in the groundwater sample.

Response. Well CW14 is located in a potential velocity stagnation zone (see figure), hence higher dissolved phase concentrations may result from longer NAPL – groundwater contact times.

Comment 7. Section 5.1: "The comparison shown on Figures 13a and Figure 13b suggest that DNAPL present in the Core Area is a stronger groundwater contaminant source than the LNAPL."

NAPL from RPW1 is largely drawn from adjacent polygon 001, 005, and 149. The TarGOST results from these boreholes show heavy contamination throughout the borehole with higher %RE values at the lower elevations. The contribution to the groundwater dissolved phase can better be explained by the TarGOST boring results.

Response. Acknowledged. It appears that the dissolved phase results confirm the TarGOST results.

Comment 8. Section 5.2: "The comparison shown on Figures 14a and Figure 14b suggest that DNAPL present in the East Shallow Area is a stronger groundwater contaminant source than the LNAPL" The TarGOST boreholes likely contributing to flows to the East Shallow Area extraction wells RPW4, RPW6, PW8 all show high %RE results for soils above 20' to 25' bgs. So groundwater contamination in the East Shallow Area is due to NAPL found in elevations largely above 20' to 25' bgs. I don't understand the emphasis placed on differentiating the source as either LNAPL or DNAPL and its impacts on remedy selection. I am assuming that any proposed treatment method/technology will be based on the locations of the contaminants.

Response. Acknowledged. The data interpretation suggests, that if a reduction of source contribution to groundwater is desired, areas of DNAPL occurrence should be prioritized.

Comment 9. Section 6: “. . . the total mass of naphthalene present in the FPA is estimated at 1.1 million kilograms (kg).”

The calculation is based on using 85% of the NAPL mass composed of LPAHs. Table 2c shows the average LPAHs is 83% of the average total PAHs and not NAPL. Table 2e uses a 0.67 mass fraction representing TPH surrogates. This resulted in a total PAH mass fraction of 0.33. The use of 85% of the NAPL mass as composed of LPAHs is not supported by the data presented in the report.

Response. Discussion Needed. Team needs to discuss what mass estimate is needed for the CSM and to support remedy selection and then we can discuss how to put this together.

Comment 10. Section 6.1: “Other PAH constituents present in the NAPL would also partition to groundwater . . . Their rate of partitioning would increase over time as their mole fraction increases in response to loss of naphthalene mass.”

If the higher molecular weight PAHs are more refractory to microdegradation, the rate of partitioning might be microdegradation rate limited. As written, the above gives me the impression that degradation rate would be increasing over time. Is that the correct interpretation?

Response. No. This discussion focuses on the partitioning of PAH constituents from the NAPL to groundwater over time. As the mass of constituents with higher aqueous solubility's decreases the dissolved phase concentration of the constituents with lower aqueous solubility's increases. In the example below, as the mass of chloromethane (which has the highest solubility) decreases, the predicted concentration of the remaining constituents increases. Other aquifer physical/chemical/biological conditions often result in observed conditions that differ from theoretical.

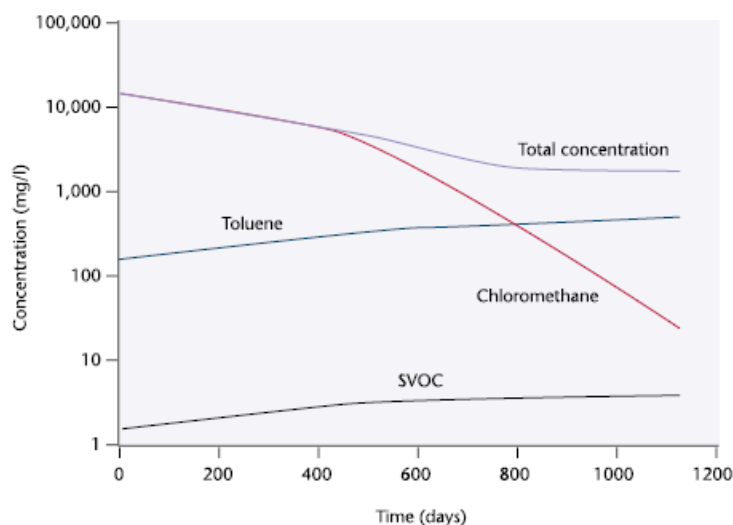


Figure 8 | Aqueous phase concentrations immediately downstream of DNAPL source

Comment 11. Section 6.2.2; “Insufficient contact time to achieve equilibrium . . . can result in pore water concentrations lower than predicted by equilibrium estimates.”

In Section 5.1, CW14 groundwater sample where phenanthrene was present at 200 µg/L or about 10 times higher than its effective solubility. What are the reasons for this higher than effective solubility concentration?

Response. See response to #6.

Comment 12. Section 6.3.5, Exhibit 1.

The well screen intervals presented in Exhibit 1 are different than the screen intervals presented in the 2014 *Conceptual Site Model Update for the Former Process Area*, Table 3-1, Wyckoff Well Data. Are the well data presented in the CSM report correct?

Response. Need to verify the source of both.